

SANKALCHAND PATEL UNIVERSITY, VISNAGAR

Faculty of Science and Humanities



**Structure, Teaching Scheme and Syllabus of
B. Sc. (Honours) Biotechnology as per NEP 2020**

Program Code: SC101

With effect from: 2023-24

SEMESTER- IV

Branch Name:	B.Sc. Biotechnology
Program Code:	SC101
Course Name:	Plant Biotechnology
Course Code:	14-BIM208-2C
Pre-requisite Course:	

Course Objectives:

- The course is designed to acquire basic knowledge of plant tissue culture and simple outline of how the micropropagation done.
- This will enable the student to understand basics of plant gene transfer. It will also help in acquiring knowledge on artificial gene transfer tools and methods for transgenesis.
- This course is designed to enable students in understanding the basics and applications of plant tissue culture.
- Understanding the Applications and Scope of Plant Genetic Engineering.

Teaching and Examination Scheme:

Teaching Scheme (Hours per week)				Evaluation Scheme (Marks)				
Lecture (L)	Tutorial (T)	Practical (P)	Credit	Theory (Marks)		Practical (Marks)		Total (Marks)
				University Assessment	Continuous Assessment	University Assessment	Continuous Assessment	
3	--	2	4	50	25	-	25	100

Subject Contents:

Unit	Topic	Total Hours	Weightage (%)
1	Overview of Tissue Culture Plant Tissue culture : History The laboratory facilities: Equipments and apparatus, Design Concepts of totipotency of cells, Concept of cytodifferentiation/ morphogenesis. Plant tissue culture media: Media composition, Types of media Selection, isolation and preparation of explant Micropropagation and its stages	12	28%
2	Techniques of tissue culture Culture of organized tissues: Root culture, shoot culture, meristem culture, embryo culture, Pollen and anther culture (production and uses of haploids.) Callus culture Protoplast culture: Somatic hybridization and its application. Somatic embryogenesis & Synthetic seeds Cell suspension culture and production of secondary metabolite Cryo preservation of germplasm	16	35%
3	Physical and chemical methods used for gene transfer in plants Agro bacterium mediated gene transfer in plants, Other biological gene transfer methods Structure of plant gene, Use of different promoters, selectable markers, reporter genes, Plant cloning vectors: Seed terminator technology Chloroplast transformation – a potential alternative to nuclear transformation Transgenic plants: Insect resistance-BT Cotton, herbicide resistance, Disease resistance, Stress tolerance, improvement of crop quality molecular pharming Post-harvest technology: RNAi and antisense RNA technology for extending shelf life of fruits (delay of softening and ripening of fleshy fruits eg. tomato)	17	37%

Text Books:

- Biotechnology in crop improvement – H S Chawla.
- Biotechnology-U. Satyanarayan.

Reference Books:

- Elements of biotechnology – P K Gupta.
- An introduction to plant tissue culture – M K Razdan.
- Plant tissue culture K.K. De.
- Plant and tissue culture Radint and Bhojwani.

List of Open Source Software/learning website:

<https://www.youtube.com/watch?v=EDReGW95EGk>

<https://www.youtube.com/watch?v=HHYDmfj4ojk>

<https://www.youtube.com/watch?v=vPkI34wXAHI>

List of Experiments:

1. Sterilization techniques: Theory and Practical: Glass ware sterilization, Media sterilization, Laboratory sterilization
2. Preparation of complex nutrient medium (Murashige & Skoog's medium)
3. To selection, Prune, sterilize and prepare an explant for culture.
4. To study various steps of Micropropagation & to study the significance of growth hormones in culture medium
5. Callus culture development

Course Learning Outcomes (CLO): On completion of this course, the students will be able to:

CLO	Description	Bloom's Taxonomy Level
CLO1	Discuss the developing an understanding towards fundamentals of plant biotechnology.	2 Understanding
CLO2	List the applications of Plant Biotechnology.	1 Remembering
CLO3	Enabling students to understand types, advantages and disadvantages molecular markers.	2 Understanding,
CLO4	Development of capacity to formulate application of plant biotechnology for production of commercial transgenic plants.	3 Applying, 2 Understanding
CLO5	Learn about biocatalysts, evaluate diseases resistant associated with plant, identify and compare the conventional propagation and micropropagation.	5,3, 4 Evaluate, , Applying, Analyze
CLO6	Discuss the mechanisms involved in gene transfer in plant.	6 Creating

Mapping of CLOs with POs & PSOs:

Course Learning Outcomes	Programme Outcomes (POs)																Programme Specific Outcome (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	PSO1	PSO2	PSO3
CLO1	2	2	3	3		2	3	1		1	1	3	1					2	1
CLO2	2	3		2	2	2	2	3	2		2	1		1	1	1	2		
CLO3		2	3			2	2		1	3		3	3				3		2
CLO4	3	3					3	2	3		2	1	1	2	1	2		2	
CLO5	3	2	2	2	3	2	2			2	1	2					2		1
CLO6	2	1	2	1	2	1		2			2		1	3	2		1	2	2

3: High, 2: Medium, 1: Low

Branch Name:	B.Sc. Biotechnology
Program Code:	SC101
Course Name:	Genetic Engineering –I
Course Code:	14-BIM209-2C
Pre-requisite Course:	Molecular Biology

Course Objectives:

- The course is designed to acquire basic knowledge of gene transfer and simple outline of how the gene can be transferred from one to the other organism.
- It will also help in acquiring knowledge on artificial gene transfer tools and methods.
- This course will enable to students to understand transposition mechanism.

Teaching and Examination Scheme:

Teaching Scheme (Hours per week)				Evaluation Scheme (Marks)				
Lecture (L)	Tutorial (T)	Practical (P)	Credit	Theory (Marks)		Practical (Marks)		Total (Marks)
				University Assessment	Continuous Assessment	University Assessment	Continuous Assessment	
3	--	2	4	50	25	-	25	100

Subject Contents:

Unit	Topic	Total Hours	Weightage (%)
1	Bacterial recombination: Principles, its biological significance, types of recombination and their molecular mechanisms (generalized-Homologous DNA recombination-Holiday Model, Non homologous site specific and illegitimate recombination), recombination frequency and its significance. Transposable genetic elements: Structure: Insertion, Types of bacterial transposons: Composite Transposons and Non composite transposons; Mechanisms of Transposition – replicative and non replicative Plasmid DNA – Introduction of Bacterial Plasmid, f –plasmids, R plasmids, colicinogenic, Other types of Plasmid	15	34%
2	Gene transfer in bacteria. Transformation: transformation principle, competence factor, mechanism of DNA uptake, transfection. Transduction: Introduction, types-restricted, generalized and abortive transduction Conjugation: Introduction, types of crosses involved: F ⁺ , Hfr and F', interrupted mating Experiment	15	33%
3	Methods of gene transfer Physical (Electroporation, Gene gun- particle bombardment, Microinjection-divert transformation, transformation by ultra sonication -liposome mediated-gene transfer, Silicon carbide based) Chemical Method (Competent cell preparation, CaCl ₂ mediated gene transfer, PEG mediated gene transfer) Biological method (Agrobacterium mediated gene transfer, Ti plasmid)	15	33%

Text Books: Prescott, Harley and Klein's Microbiology.9th Edition. McGraw Hill Higher education.

Reference Books:

- Brown TA.(2010). Gene Cloning and DNA Analysis. 6th edition. Blackwell Publishing, Oxford,U.K.
- Molecular Cell Biology 5 th edition by Lodish, Berk, Matsudalia Clark DP and Pasternik NJ. (2009).
- Biotechnology: Applying the Genetic Revolution, Primrose SB and Twyman RM. (2008), Elsevier Academic Press, USA
- Genomics: Applications in human biology. Blackwell Publishing, Oxford, U.K.
- Principles of Microbiology by R. M. Atlas

List of Open Source Software/learning website

<https://archive.nptel.ac.in/noc/courses/noc22/SEM1/noc22-bt22/>

<https://archive.nptel.ac.in/noc/courses/noc18/SEM1/noc18-bt02/>

<https://archive.nptel.ac.in/noc/courses/noc21/SEM1/noc21-bt17/>

<https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=MNhNzp1RQIU+6LM40KjY1Q==>

List of Experiments:

1. Isolation and quantification of DNA from Bacteria.
2. Extraction of plasmid DNA from bacterial cell.
3. Study & Visualization of DNA using Agarose Gel Electrophoresis.
4. Preparation of Competent cell for Transformation.
5. Transformation and selection of recombinants.
6. To study and schematically demonstrate phenomena of Conjugation.
7. To study and schematically demonstrate phenomena of Transduction.

Course Learning Outcomes (CLO): On completion of this course, the students will be able to:

CLO	Description	Bloom's Taxonomy Level
CLO1	Discuss the mechanism of conjugation.	2 Understanding
CLO2	List the types of gene transfer.	1 Remembering
CLO3	Enabling students to understand types, advantages and disadvantages transgenesis.	2 Understanding,
CLO4	Development of capacity to understand recombination.	3 Applying, 2 Understanding
CLO5	Learn about transposable element, evaluate mechanisms associated with it, identify and compare the different types of it.	5,3, 4 Evaluate, , Applying, Analyze
CLO6	Discuss the mechanisms involved in transduction.	6 Creating

Mapping of CLOs with POs & PSOs:

Course Learning Outcomes	Programme Outcomes (POs)																Programme Specific Outcome (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	PSO1	PSO2	PSO3
CLO1	3	3	2	2	3	3	3	2	3		1	3	1		1		2	2	3
CLO2	2	2			1	3	3	3	1		2			2	2	1		1	
CLO3	2	3	2				2	2	3	1		3	3				1		2
CLO4	3	3	1	2				1	2	2	3	1		2	3	2	2	2	
CLO5	2	1	2	2	2	2	1	2		2	3	3	1	1	2		2	2	3
CLO6	2	2	2		2	1	1	2	1	1	3	2	2	3		2			2

3: High, 2: Medium, 1: Low

Branch Name:	B.Sc. Biotechnology
Program Code:	SC101
Course Name:	Genetic Engineering –II
Course Code:	14-BIM210-2C
Pre-requisite Course:	Molecular Biology

Course Objectives:

- The course is designed to acquire basic knowledge of Nucleic acid isolation, various methods of DNA manipulation, hybridization
- It will also help in acquiring knowledge of gene cloning (Prokaryotes and Eukaryotes)
- This course will enable students to understand DNA sequencing, PCR, Molecular Markers, etc

Teaching and Examination Scheme:

Teaching Scheme (Hours per week)				Evaluation Scheme (Marks)				
Lecture (L)	Tutorial (T)	Practical (P)	Credit	Theory (Marks)		Practical (Marks)		Total (Marks)
				University Assessment	Continuous Assessment	University Assessment	Continuous Assessment	
3	--	2	4	50	25	-	25	100

Subject Contents:

Unit	Topic	Total Hours	Weightage (%)
1	Basic Requirements for Molecular Biology Laboratory Various Approaches of nucleic acid Isolation (DNA & RNA), Quality and Quantity determination of isolated nucleic acid Various methods of DNA manipulation – Digestion, Ligation, labelling. Blotting and Hybridization: Southern, Northern, Western, Colony, dot blot, Hybridization and detection by autoradiography and Fluorescence Colony hybridization technique Sequencing of DNA: Sanger's method for DNA sequencing, automated DNA sequencings, pyro-sequencing and microarraybased sequencing. Chemical and automated DNA Synthesis, Next Generation Sequencing. Gene library construction (Genomic & c-DNA library)	15	33%
2	Enzymes: restriction endonucleases, RNA polymerase, DNA ligase, alkaline phosphatase, reverse transcriptase. Cloning and expression vectors: Plasmid based vectors, bacteriophage lambda based vectors, cosmids, P1 based vector, PAC, BAC, Phagemids, High capacity yeast cloning vector:-YAC, specialized yeast vectors: pYES and pPICZ Gene cloning in prokaryotes – isolation of DNA to be cloned – insertion of DNA fragments into vector – use of linkers and adaptors- use of homopolymer tails, transfer of recombinant DNA into bacterial cells. Cloning in eukaryotes in plant cell, yeast, filamentous fungi	15	33%
3	Genome mapping: Molecular markers (RFLP, RAPD, AFLP, SNP, SCAR, SSR, VNTR). Chromosome walking. Polymerase chain reaction techniques: Basic PCR technique, Variation of PCR techniques and Applications of PCR. Applications of r-DNA technology: Gene therapy, Expression of therapeutic proteins, Forensic science, Food, Agriculture. Gene Editing Strategies	15	34%

Text Books:

Brown TA. (2010). Gene Cloning and DNA Analysis. 6th edition. Blackwell Publishing, Oxford, U.K.

Reference books:

1. Molecular Cell Biology 5th edition by Lodish, Berk, Matsudalia Clark DP and Pasternik NJ. (2009).
2. Biotechnology: Applying the Genetic Revolution. ElsevierAcademic Press, USA
3. Primrose SB and Twyman RM. (2006).Principles of Gene Manipulation and Genomics, 7th edition.
4. Blackwell Publishing, Oxford, U.K.
5. Sambrook J and Russell D. (2001). Molecular Cloning-A Laboratory Manual. 3rd edition. Cold
6. Genetics: principles and analysis. 4 th edition 1998, Denial L. Hartl, Elizabeth tones.
7. Principles of genetics: E.J. Gardner. Genes 9: Benjamin Levi
8. Lehninger Principles of Biochemistry, 5th Edition, Nelson DL and Cox MM (2008).W.H. Freeman and Company
9. Microbiology Powar and Daginawala
10. Biotechnology by S. S. Purohit.
11. Genetic Engineering by Sandhya Mitra
12. Fundamentals of Molecular Biology 2009, Tar ganti K. Pal, Saroj S.
13. Cell biology& Genetics: Verma and Agrawal

List of Open-Source Software/learning website:

<http://ecoursesonline.iasri.res.in/course/resources.php?id=419>

<https://www.coursera.org>

<https://onlinecourses.nptel.ac.in>

List of Experiments:

1. Amplification of DNA by PCR
2. To perform restriction digestion.
3. Ligation of digested DNA.
4. To isolate DNA from Plant.
5. To isolate DNA from Animal Tissue.
6. To study and schematically demonstrate phenomena of Transduction RFLP.

Course Learning Outcomes (CLO): On completion of this course, the students will be able to:

CLO	Description	Bloom's Taxonomy Level
CLO1	Discuss the mechanism of DNA isolation, manipulation, hybridization experiments.	2 Understanding
CLO2	List the types of PCR. Various types of gene transfer methods	1 Remembering
CLO3	Enabling students to understand types, advantages and disadvantages various molecular markers.	2 Understanding,
CLO4	Development of capacity to understand DNA sequencing, Chromosome walking.	3 Applying, 2 Understanding
CLO5	Learn about PCR, Prokaryotic and Eukaryotic Gene cloning	5,3, 4 Evaluate, , Applying, Analyze
CLO6	Discuss the mechanisms involved in pyrosequencing, gene transfer techniques, NGS.	6 Creating

Mapping of CLOs with POs & PSOs

Course Learning Outcomes	Programme Outcomes (POs)																Programme Specific Outcome (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	PSO1	PSO2	PSO3
CLO1	3	3	2	2	3	3	3	2	3		1	3				1	2	2	3
CLO2	2	2			1	3	3	3	1		2		1	2	1			1	
CLO3	2	3	2				2	2	3	1		3				2	1		2
CLO4	3	3	1	2	2			1	2	2	3	1	3	1	2	1	2	2	3
CLO5	2	1	2	2	2	2	1	2		2	3	3	2				2	2	2
CLO6	2	2	2			2	1	2	1	1	3	2	1		1	2			

3: High, 2: Medium, 1: Low

Branch Name:	B.Sc. Biotechnology
Program Code:	SC101
Course Name:	Bryophytes, Pteridophytes and Gymnosperms
Course Code:	14-BIE206-2C
Pre-requisite Course:	Basics Biology

Course Objectives:

- Demonstrate an understanding of archegoniatae, Bryophytes, Pteridophytes and Gymnosperms.
- Develop critical understanding on morphology, anatomy and reproduction of Bryophytes, Pteridophytes and Gymnosperms.
- Understanding of plant evolution and their transition to land habitat.
- Demonstrate proficiency in the experimental techniques and methods of appropriate analysis of Bryophytes, Pteridophytes, Gymnosperms.

Teaching and Examination Scheme:

Teaching Scheme (Hours per week)				Evaluation Scheme (Marks)				
Lecture (L)	Tutorial (T)	Practical (P)	Credit	Theory (Marks)		Practical (Marks)		Total (Marks)
				University Assessment	Continuous Assessment	University Assessment	Continuous Assessment	
3	--	2	4	50	25	-	25	100

Subject Contents:

Unit	Topic	Total Hours	Weightage (%)
1	Diversity of Bryophytes General Characters and group characteristics with suitable examples Occurrence, thallus structure, Morphology, anatomy and reproduction in: Marchantia, Peltia, Anthoceros and Polytrichum	15	33%
2	Diversity of Pteridophytes General characters and group characteristics with suitable examples Morphology, anatomy and reproduction in: Lycopodium, Isoetes, Marsilea, Osmunda and Adiantum	15	34%
3	Diversity of Gymnosperms General characteristics and group characteristics with suitable examples Morphology, anatomy and reproduction in: Zamia, Pinus, Biota and Ephedra	15	33%

Text Books:

- Smith, G.M. 1972 Cryptogamic Botany Vol I and II
- Vasishtha, B.R. 1974 Botany for Degree students Vol I Algae
- Vasishtha, B.R. 1974 Botany for Degree students Vol III Bryophyta
- Vasishtha, P.C. 1974 Botany for Degree students Vol IV Pteridophyta
- Vasishtha, P.C. 1976 Botany for Degree students Vol V Gymnosperms
- Bhatnagar, S.P. and Alok Moitra 1996. Gymnosperms New Age International Publishers
- Inderdeep Kaur and Prem Lal Uniyal 2019. Text book of Gymnosperms Daya Publishing house

List of Open Source Software/learning website:

<https://www.youtube.com/watch?v=eN5ROvxp8Q>

<https://archive.nptel.ac.in/noc/courses/noc22/SEM1/noc22-bt17/>

<https://archive.nptel.ac.in/noc/courses/noc22/SEM1/noc22-bt18/>

<https://archive.nptel.ac.in/courses/102/103/102103091/>

<https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=2rAs1Puvga4LW93zMe83aA==>

List of Experiments:

Morphology and anatomy of vegetative and reproductive parts in:

- *Oedogonium, Chara, Dictyota, Batrachospermum*
- *Marchantia, Anthoceros, Polytrichum*
- *Lycopodium, Isoetes, Marsilea, Adiantum*
- *Zamia, Pinus, Biota*

Course Learning Outcomes (CLO): On completion of this course, the students will be able to:

CLO	Description	Bloom's Taxonomy Level
CLO1	Discuss the diversity of bryophytes.	2 Understanding
CLO2	List the diverse group of pteridophytes.	1 Remembering
CLO3	Acquire fundamentals knowledge that will enable them to identify and study Gymnosperms.	2 Understanding,
CLO4	Learn basic techniques to identify and interpret Protein synthesis and transporting in the cell.	3 Applying, 2 Understanding
CLO5	Learn about membrane transport, evaluate diseases associated with them, identify and compare the exocytosis and endocytosis in the cell.	5,3, 4 Evaluate,Applying, Analyze
CLO6	Discuss the mechanisms involved in mitosis and meiosis.	6 Creating

Mapping of CLOs with POs & PSOs:

Course Learning Outcomes	Programme Outcomes (POs)																Programme Specific Outcome (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	PSO1	PSO2	PSO3
CLO1	1	1	1		1	1											1	1	
CLO2	1	3	1		1	1									2		3	3	3
CLO3	1	3	1		2	2			2						1		3	3	3
CLO4	2	3	1		3	3			3								3	3	3
CLO5	2	3	3		3	3			3						3		3	3	3
CLO6	3	3	3		3	3			3								1	1	2

3: High, 2: Medium, 1: Low

Branch Name:	B.Sc. Biotechnology
Program Code:	SC101
Course Name:	Biodiversity of Microbes
Course Code:	14-MIE208-2C
Pre-requisite Course:	

Course Objectives:

- To understand basic information to origin and diversity of microbes
- To understand characteristics of various microorganisms other than bacteria
- To understand the concepts of taxonomy and phylogenetic relationships between various domains
- To understand the diversity amongst the different domains and diversity in-between the same domain
- To enable the students useful and harmful effects of microorganisms on other organisms of various domains

Teaching and Examination Scheme:

Teaching Scheme (Hours per week)				Evaluation Scheme (Marks)				
Lecture (L)	Tutorial (T)	Practical (P)	Credit	Theory (Marks)		Practical (Marks)		Total (Marks)
				University Assessment	Continuous Assessment	University Assessment	Continuous Assessment	
3	--	2	4	50	25	-	25	100

Subject Contents:

Unit	Topic	Total Hours	Weightage (%)
1	INTRODUCTION TO MICROBIAL DIVERSITY - Introduction to Biodiversity- Microbial evolution and diversity; Major domains of life; Overview of the functional and metabolic diversity between- the similar domains and the different domains - Microbial Taxonomy: Major characteristics used in taxonomy classical and molecular; Classification systems-phenetic, numerical and phylogenetic; Taxonomic ranks of microorganisms ARCHAEA: General Characteristics- Difference between Archaea and Bacteria, Major divisions of Archaea: <i>Euryarchaeota</i>, <i>Thaumarchaeota</i>, <i>Nanoarchaeota</i>, and <i>Korarchaeota</i>, <i>Crenarchaeota</i> Evolution and Life at High Temperatures: Molecular adaptations and Hyperthermophilic Archaea	15	34%
2	EUKARYOTIC DIVERSITY FUNGI: General characteristics – Definition, occurrence, Structure, reproduction, Classification and introduction to major divisions of Fungi; Economic importance of fungi ALGAE: General Characteristics – Definition, reproduction Occurrence, Ultra Structure, Economic importance of Algae PROTOZOA: General Characteristics – Definition, Occurrence, Ultra Structure, reproduction, Economic importance of Protozoa	15	33%
3	AKARYOTIC DIVERSITY-(VIRUSES) - Introduction and General Characteristics: Definition, Structure, Classification - Cultivation and Enumeration of Viruses. Viroids and Prions - Bacterial Viruses: Classification, Lytic life cycle (T4 phage), lysogenic life cycle - Plant Virus: TMV, CMV - Animal Virus: Poliovirus, HIV	15	33%

Text Books: Michael Pelczar, text book of microbiology, 5th ed.

Reference Books:

1. Madigan MT, and Martinko J M (2014). Brock Biology of Microorganisms. 14th edition. Prentice Hall International Inc.
1. Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott's Microbiology. 9th edition. McGraw Hill Higher Education
2. Microbiology by R.M. Atlas (1996).
3. Practical Microbiology by Dr. R.C. Dubey and Dr. D.K. Maheshwari (2008).

List of Open Source Software/learning website:

<https://archive.nptel.ac.in/courses/102/103/102103015/>

https://onlinecourses.nptel.ac.in/noc21_ce07/preview

<https://www.studocu.com/in/document/amity-university/microbiology/diversity-of-microbial-world/4680392>

<https://academic.oup.com/book/504/chapter-abstract/135265982?redirectedFrom=fulltext>

List of Experiments:

1. Isolation and culture of photosynthetic bacteria
2. Isolation and culture of halophilic bacteria
3. Isolation and enumeration of fungi from different samples
4. Isolation of yeast from sugary/starchy material
5. Isolation and identification of algae from soil
6. Isolation and enumeration of phage from sewage sample
7. Isolation of protozoa from soil

Course Learning Outcomes (CLO): On completion of this course, the students will be able to:

CLO	Description	Bloom's Taxonomy Level
CLO1	Categorize and classify various domains on the basis of their characteristics, and illustrate their classical and molecular characters for the classification of different living organisms	1 Remembering 2 Understanding 3 Applying 4 Analyzing
CLO2	Compare physiology of the organisms of same and/or different domains, illustrate the classification of organisms on the basis of taxonomic rank	1 Remembering 2 Understanding
CLO3	Categorize and classify Eukaryotic organisms, Classify the fungi on the basis of phenotypic characters, and illustrate the economic importance of fungi, and clinically important fungi	1 Remembering 2 Understanding
CLO4	Classify the fungi on the basis of phenotypic characters, and illustrate the economic importance of fungi, and clinically important fungi	1 Remembering 2 Understanding
CLO5	Categorize and classify akaryotic organisms, Classify the virus on the basis of the nucleic acid material, and illustrate the clinical importance of viruses	1 Remembering 2 Understanding 3 Applying 4 Analyzing 5 Evaluating
CLO6	Illustrate the viruses that can cause infections to bacteria, plants, and animals	3 Applying 2 Understanding 4 Analyzing 5 Evaluating 6 Creating

Mapping of CLOs with POs & PSOs:

Course Learning Outcomes	Programme Outcomes (POs)																Programme Specific Outcome (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	PSO1	PSO2	PSO3
CLO1						2								1			1	1	
CLO2						2								1			1		1
CLO3						3								2				1	
CLO4						2								2					1
CLO5						3								2			1		
CLO6						3								1					1

3: High, 2: Medium, 1: Low

Branch Name:	B.Sc. Biotechnology
Program Code:	SC101
Course Name:	Grammar and Communication Skill-II
Course Code:	14-AEC204-2C
Pre-requisite Course:	Basics English Grammar Basics English up to S.Y.B.Sc.

Course Objectives:

- To inculcate human values among the students through poems and prose.
- To create an interest in literature and to develop language skills.
- The students will become familiar with formal vocabulary that is common in academic texts.

Teaching and Examination Scheme:

Teaching Scheme (Hours per week)				Evaluation Scheme (Marks)				
Lecture (L)	Tutorial (T)	Practical (P)	Credit	Theory (Marks)		Practical (Marks)		Total (Marks)
				University Assessment	Continuous Assessment	University Assessment	Continuous Assessment	
2	--	--	2	25	25	--	--	50

Subject Contents:

Sr. No	Topic	Total Hours	Weightage (%)
1	VOCABULARY&GRAMMARLINK Prefix-Suffix, Gerund and Participle, Concord, Apply capitalization and comma use rules. Sentences: Simple Sentences, Compound Sentences, Complex Sentences.	9	30%
2	SPEAKING conversations:- College/School related conversations:- Parent – teacher, Advice from a teacher, Admission to a college , Getting ready for a school trek. Family conversations:- A family get together , Cleaning the house , Sharing the day’s experiences Job related Enquiries:- Job seekers’ course , Job seekers - a discussion , Job opportunities , Short courses during a vacation	6	20%
3	READING&WRITING Paragraph Writing. List of Topics for Paragraph Writing: Personal: (a) My Ambition in Life (b) India - My Country (c) College Life (d) My Favorite Movie State/ nation/ media: (a) My City/ Village (b) My Favorite Sports person (c) Gandhi Ashram (d) Importance of English in India Environment/ social life: (a) Pollution (b) Traffic Awareness (c) Trees – Our Best Friends (d) Gender Discrimination Translation:- Translate the Accident/Incident Paragraphs given by your teacher from the English News Papers (Teacher has to give small paragraphs at least 5 to 6 paragraphs or more than that for the entire semester based on especially from the pages no. 3 & 4 of The Times of India)	6	20%
4	TEXT Glimpses of Life-An Anthology of Short Stories (Orient Black Swan) Lesson 8 to 12	9	30%

Text Books:

1. Glimpses of Life-An Anthology of Short Stories (Orient Black Swan)
2. Easy to learn English grammar by Dr.Jayesh Patel

Reference Books:

1. Very Useful Verbs book (Enka Publication)
2. Contemporary English Grammar Structure & Composition
3. Murphy R. Intermediate English Grammar(New Delhi: Cambridge University)
4. The Art of Public Speaking by Vijay Kumar.
5. The Times of India/The Indian Express.
6. Business Correspondence and Report Writing by R.C Sharma & Krishna Mohan.

List of Open Source Software/learning website:

1. englishpage.com
2. epaper.timesofindia.com
3. epaperindianexpress.com
4. <https://www.youtube.com/watch?v=QdAgyD4xhY>

Course Learning Outcomes (CLO): On completion of this course, the students will be able to:

CLO	Description	Bloom's Taxonomy Level
CLO1	Describe how public speaking can be used to advocate or create change	1 Remembering
CLO2	Explain the goals and benefits of public speaking	2 Understanding
CLO3	Use parallel structures correctly and effectively.	3 Applying
CLO4	Identify strategies for researching and supporting a speech	4 Analyzing
CLO5	Recognize when to use visual aids	3 Applying
CLO6	Describe how public speaking can be used to advocate or create change	6 Creating

Mapping of CLOs with Pos & PSOs

Course Learning Outcomes	Programme Outcomes (POs)																Programme Specific Outcome (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	PSO1	PSO2	PSO3
CLO1				3			1												
CLO2				3			1												
CLO3				3			1												
CLO4				3			1												
CLO5				3			1												
CLO6				3			1												

3: High, 2: Medium, 1: Low

Branch Name:	B.Sc. Biotechnology
Program Code:	SC101
Course Name:	Biofertilizers and Biopesticide
Course Code:	14-SEC218-2C
Pre-requisite Course:	Basic knowledge of Microbiology

Course Objectives:

- To understand Biofertilizers
- To understand nitrogen fixing bacteria
- To understand Mycorrhizal Biofertilizers
- To understand Biopesticides

Teaching and Examination Scheme:

Teaching Scheme (Hours per week)				Evaluation Scheme (Marks)				
Lecture (L)	Tutorial (T)	Practical (P)	Credit	Theory (Marks)		Practical (Marks)		Total (Marks)
				University Assessment	Continuous Assessment	University Assessment	Continuous Assessment	
2	--	--	2	25	25	--	--	50

Subject Contents:

Unit	Topic	Total Hours	Weightage (%)
1	Importance of Biofertilizers its advantage over chemical fertilizers and their limitations General account of the microbes used as biofertilizers for various crop plants Symbiotic N₂ fixers: Rhizobium - Isolation, characteristics, types, inoculum production and field application, legume/pulses plants Frankia - Isolation, characteristics, Alder, Casurina plants, non-leguminous crop symbiosis. (A) Cyanobacteria, Azolla - Isolation, characterization, mass multiplication, Role in rice cultivation, Crop response, field application. (B) Non - Symbiotic Nitrogen Fixers Free living Azospirillum, Azotobacter - free isolation, characteristics, mass inoculums, production and field application. (C) Phosphate Solubilizers Phosphate solubilizing microbes - Isolation, characterization, mass inoculum production, field application (D) Mycorrhizal Biofertilizers Importance of mycorrhizal inoculum, types of <i>Mycorrhizae</i> and associated plants, Mass inoculum production of VAM, field applications of Ectomycorrhiza and VAM.	24	80%
2	Biopesticide General account of microbes used as biopesticide and their advantages over synthetic pesticides. Biopesticide, <i>Bacillus thuringiensis</i>- production and Field applications Viruses – cultivation and field applications.	6	20%

Text Books:

Michael Pelczar, text book of microbiology, 5thed.

Reference Books:

1. Kannaiyan, S. (2003). Bioethnology of Biofertilizers, CHIPS, Texas.
2. Mahendra K. Rai (2005). Hand book of Microbial biofertilizers, The Haworth Press, Inc. New York.
3. Reddy, S.M. et. al. (2002). Bioinoculants for sustainable agriculture and forestry, Scientific Publishers.
4. Subba Rao N.S (1995) Soil microorganisms and plant growth Oxford and IBH publishing co. Pvt. Ltd. NewDelhi.
5. Saleem F and Shakoori AR (2012) Development of Bioinsecticide, Lap Lambert Academic Publishing GmbH KG
6. Aggarwal SK (2005) Advanced Environmental Biotechnology, APH publication.

List of Open Source Software/learning website:

<https://onlinecourses.swayam2.ac.in>

<https://archive.nptel.ac.in/courses>

<https://onlinecourses.nptel.ac.in>

<https://www.coursera.org>

Course Learning Outcomes (CLO): On completion of this course, the students will be able to:

CLO	Description	Bloom's Taxonomy Level
CLO1	List and understand the concept of Biofertilizers	1 Remember 2 Understanding
CLO2	General account of the microbes used as biofertilizers	1 Remembering 2 Understanding 3 Applying
CLO3	Discuss Nitrogen fixing bacteria and its importance.	2 Understanding 3 Applying 4 Analyze
CLO4	Mycorrhizal Biofertilizers its mechanism and uses.	1 Remembering 2 Understanding 3 Applying 4 Analyze
CLO5	General account of microbes used as biopesticide with an example of <i>Bacillus thurengensis</i> .	3 Applying, 5 Evaluate
CLO6	Learn about the microbes used in agricultural area which helps to design a biofertilizer or biopesticide for the field	3 Applying, 6 Create

Mapping of CLOs with POs & PSOs:

Course Learning Outcomes	Programme Outcomes (POs)																Programme Specific Outcome (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	PSO1	PSO2	PSO3
CLO1	1	2			1	1								3			1		
CLO2														3					1
CLO3						1								3				2	
CLO4						1								3					
CLO5						1								3					1
CLO6		2	2			2								3					

3: High, 2: Medium, 1: Low

Branch Name:	B.Sc. Biotechnology
Program Code:	SC101
Course Name:	Nanobiotechnology
Course Code:	14-SEC219-2C
Pre-requisite Course:	Basic Science

Course Objectives:

1. To identify and classify Microbes
2. Understanding various classification scheme with details of five kingdom concept
3. Knowing application and scope of microbiology in various fields

Teaching and Examination Scheme:

Teaching Scheme (Hours per week)				Evaluation Scheme (Marks)				
Lecture (L)	Tutorial (T)	Practical (P)	Credit	Theory (Marks)		Practical (Marks)		Total (Marks)
				University Assessment	Continuous Assessment	University Assessment	Continuous Assessment	
2	--	--	2	25	25	--	--	50

Subject Contents:

Unit	Topic	Total Hours	Weightage (%)
1	Basics of biology - cell, organelles and nucleic acids as genetic material. Biomacromolecules - Carbohydrates, lipids, proteins and Nucleic acids. Nanomaterial in biotechnology - nanoparticles, quantum dots, nanotubes and nanowires etc. Development of nanobiotechnology – timelines and progress, overview. Biosensors: different classes molecular recognition elements, transducing elements. Applications of molecular recognition elements in nanosensing of different analytes. Application of various transducing elements as part of nanobiosensors.	15	50
2	Miniaturized devices in nanobiotechnology - types and applications, lab on a chip concept. Biological nanoparticles production - plants and microbial. Nanobiotechnological applications in health and disease - infectious and chronic. Nanobiotechnological applications in Environment and food - detection and mitigation.	15	50

Text Books:

1. Nanotechnology in Biology and Medicine: Methods, Devices, and Applications.

Reference Books:

1. Nanobiotechnology: Concepts, Applications and Perspectives (2004), Christof M. Niemeyer (Editor), Chad A. Mirkin (Editor), Wiley VCH.
2. Nanobiotechnology - II more concepts and applications. (2007) - Chad A Mirkin and Christof M. Niemeyer (Eds), Wiley VCH.

List of Open Source Software/learning website:

<https://www.youtube.com/watch?v=dQhhcgn8YZo>
<https://www.youtube.com/watch?v=0jb3FdYeh4>

Course Learning Outcomes (CLO): On completion of this course, the students will be able to:

CLO	Description	Bloom's Taxonomy Level
CLO1	List and understand the concept of Biosensors.	1 Remember 2 Understanding
CLO2	General account of the cell organelles as cell functioning units	1 Remembering 2 Understanding 3 Applying
CLO3	Discuss biomolecules and its importance.	2 Understanding 3 Applying 4 Analyze
CLO4	Molecular recognition elements and various transducing elements its mechanism and uses.	1 Remembering 2 Understanding 3 Applying 4 Analyze
CLO5	General account of s lab chip concept used as miniaturized devices.	3 Applying, 5 Evaluate
CLO6	Learn about the bionanoparticals and nanotechnology used in agricultural, environmental, food and health area which helps to disease recognition.	3 Applying, 6 Create

Mapping of CLOs with POs & PSOs:

Course Learning Outcomes	Programme Outcomes (POs)																Programme Specific Outcome (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	PSO1	PSO2	PSO3
CLO1	3	3								3				2	1		3	3	3
CLO2	3	3															3		
CLO3	3	3		3													3		
CLO4	3	3	3	3						3				1	1		3	3	3
CLO5	3	3	3	2						3				2	2		3	3	3
CLO6	3	3	3	2						3				3	3		3	3	3

3: High, 2: Medium, 1: Low

Branch Name:	B.Sc. Biotechnology
Program Code:	SC101
Course Name:	Environmental Science
Course Code:	14-VAC202-2C
Pre-requisite Course:	Basic knowledge of 11-12 th Science

Course Objectives:

- To provide students with a broad interdisciplinary liberal arts framework for understanding the relationship between humans and their environment.
- To prepare students for careers, citizenship and environmental stewardship through experiential curricular and co-curricular opportunities.
- To equip students with the knowledge and skills necessary to pursue professional careers and advanced study related to the multi-faceted nature of environmental studies.
- Students by offering this course will get proper understanding of important aspects that affects environment and ecology

Teaching and Examination Scheme:

Teaching Scheme (Hours per week)				Evaluation Scheme (Marks)				
Lecture (L)	Tutorial (T)	Practical (P)	Credit	Theory (Marks)		Practical (Marks)		Total (Marks)
				University Assessment	Continuous Assessment	University Assessment	Continuous Assessment	
2	-	-	2	25	25	-	-	50

Subject Contents:

Unit	Topic	Total Hours	Weightage (%)
1	Introduction to Environment and Environmental Studies: Definition and Components of Environment, Relationship between the different components of Environment, Man and Environment relationship, Impact of technology on Environment, Environmental Degradation, Multidisciplinary nature of the Environment studies, its scope and importance in the present day Education System Ecology and Ecosystems: Introduction: Ecology- Objectives and Classification, Concept of an ecosystem- structure and functions of ecosystem Components of ecosystem- Producers, Consumers, Decomposers Bio-Geo-Chemical Cycles- Hydrologic Cycle, Carbon cycle, Energy Flow in Ecosystem, Food Chains, Food webs, Ecological Pyramids Major Ecosystems: Forest Ecosystem, Grassland Ecosystem, Desert Ecosystem, Aquatic Ecosystem, Estuarine Ecosystem.	15	50%
2	Human Population and Environment: Population Growth, World and Indian scenario, Population and Environmental Degradation, Malthusian theory, Optimum theory, Population explosion – Causes, Effects and Control. Urbanization: Urban population growth and Environmental problems Environmental pollution: Types of Environmental Pollution: 1) Water Pollution: Introduction – Water Quality Standards, Sources of Water Pollution: Industrial, Agricultural, Municipal; Classification of water pollutants, Effects of water pollutants, Eutrophication 2) Air Pollution: Composition of air, Structure of atmosphere, Ambient Air Quality Standards, Classification of air pollutants, Sources of common air pollutants like PM, SO ₂ , NO _x , Natural & Anthropogenic Sources, Effects of common air pollutants	15	50%

	3) Land Pollution: Land uses ,Land degradation: causes, effects and control, soil erosion 4) Noise Pollution: Introduction, Sound and Noise, Noise measurements, Causes and Effects 5) Thermal Pollution: Causes and effects Role of individual in the prevention of pollution		
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Text Books: Textbook of Environmental Studies for Undergraduate Courses by Erach Bharucha Second edition, 2013 Publisher: Universities Press (India) Private Ltd, Hyderabad.

Reference Books:

1. Basics of Environmental Studies by Prof Dr N S Varandani, 2013 Publisher: LAP -Lambert Academic Publishing, Germany
2. Environmental Studies by Anindita Basak ,2009 Publisher: Drling Kindersley(India)Pvt. Ltd Pearson
3. Textbook of Environmental Studies by Deeksha Dave & S SKateva, Cengage Publishers.
4. Environmental Sciences by Daniel B Botkin& Edward A Keller Publisher: John Wiley & Sons.
5. Environmental Studies by R. Rajagopalan, Oxford University Press
6. Environmental Studies by Benny Joseph, TMH publishers
7. Environmental Studies by Dr. Suresh K Dhameja, 2007 Published by: S K Kataria& Sons New Delhi
8. Basics of Environmental Studies by U K Khare, 2011 Published by Tata McGraw Hill

List of Open Source Software/learning website:

1. <https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=0Xvq9yUM2ILDrJ07FvlArQ==>
2. <https://nptel.ac.in/courses/120108004>

Course Learning Outcomes (CLO): On completion of this course, the students will be able to:

CLO	Description	Bloom's Taxonomy Level
CLO1	Use critical thinking, problem-solving, and the methodological approaches of the social sciences, natural sciences, and humanities in environmental problem solving.	3 Apply
CLO2	Demonstrate an integrative approach to environmental issues with a focus on sustainability.	2 Understanding
CLO3	Communicate complex environmental information to both technical and non-technical audiences.	2 Understanding 3 Apply
CLO4	Understand and evaluate the global scale of environmental problems.	1 Remembering 2 Understanding
CLO5	Predicting the consequences of human actions on the web of life, global economy and quality of human life.	1 Remembering 2 Understanding
CLO6	Adopting sustainability as a practice in life, society and industry.	2 Understanding

Mapping of CLOs with POs & PSOs:

Course Learning Outcomes	Programme Outcomes (POs)																Programme Specific Outcome (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	PSO1	PSO2	PSO3
CLO1	3	3	2											3	2				2
CLO2	2	2	3											3	2		1	1	3
CLO3			2							2				3	2		2	1	1
CLO4	1	1	1											3	2		1	1	3
CLO5														3	2		1		2
CLO6														3	2		1		3

3: High, 2: Medium, 1: Low

Branch Name:	B.Sc. Biotechnology
Program Code:	SC101
Course Name:	Integrated Personality Development Course
Course Code:	14-VAC203-2C
Pre-requisite Course:	Zeal to Learn the Subject

Course Objectives:

- To provide students with a holistic education – focused on increasing their intelligence quotient, spiritual quotient, emotional quotient and physical quotient.
- To provide students with hard and soft skills, making them more marketable when entering the workforce.
- To educate students on their social responsibilities as citizens of India and have a greater sense of social responsibility.
- To provide students with a value-based education this will enable them to be successful in their family, professional, and social relationships by improving their moral and ethical values.
- To teach self-analysis and self-improvement exercises to enhance the potential of the participants.
- To have a broader sense of self-confidence and a defined identity

Teaching and Examination Scheme:

Teaching Scheme (Hours per week)				Evaluation Scheme (Marks)				
Lecture (L)	Tutorial (T)	Practical (P)	Credit	Theory (Marks)		Viva voce (Marks)		Total (Marks)
				University Assessment	Continuous Assessment	University Assessment	Continuous Assessment	
-	--	4	2	-	-	25	25	100

Subject Contents:

Unit	Topic	Total Hours	Weightage (%)
1	Introduction: The Need for Values Remaking Yourself: Restructuring Yourself, Power of Habit Learning from Legends: Tendulkar & Tata From House to Home: Listening & Understanding	20	34
2	Facing Failures: Welcoming Challenges, Significance of Failures My India My Pride: Glorious Past - Part 1, Glorious Past - Part 2 Learning from Legends: A.P.J. Abdul Kalam Soft Skills: Networking & Leadership, Project Management	20	33
3	Remaking Yourself: Handling Social Media Facing Failures: Power of Faith From House to Home: Bonding the Family Selfless Service: Seva	20	33

Text Books:

IPDC Workbook-1 (Presented by B.A.P.S. Swaminarayan Sanstha)

Reference Books:

1. Thomas Edison's factory burns down, New York Times Archives, Page 1, 10/12/1914
2. Playing It My Way: My Autobiography, Sachin Tendulkar, Hodder & Stoughton, 2014
3. The Rise of Civilization in India and Pakistan, Raymond Allchin, Bridget Allchin, Cambridge University Press, 1982
4. Seven Habits of Highly Effective Teens, Sean Covey, Simon & Schuster, 2012

List of Open Source Software/learning website:

<https://www.youtube.com/watch?v=r6LtC1prqLs>

<https://www.youtube.com/watch?v=oxoZW6RMspI>

<https://www.youtube.com/watch?v=FWCTTsAR4Zg>

Course Learning Outcomes (CLO): On completion of this course, the students will be able to:

CLO	Description	Bloom's Taxonomy Level
CLO1	To provide students with a holistic value-based education that will enable them to be successful in their academic, professional, and social lives.	1 Remembering 2 Understanding 3 Applying
CLO2	To give the students the tools to develop effective habits, promote personal growth, and improve their wellbeing, stability, and productivity.	1 Remembering 2 Understanding 3 Applying
CLO3	To allow students to establish a stronger connection with their family through critical thinking and devolvement of qualities such as unity, forgiveness, empathy, and effective communication.	1 Remembering 2 Understanding 3 Applying
CLO4	To provide students with soft skills that complement their hard skills, making them more marketable when entering the workforce.	1 Remembering 2 Understanding 3 Applying
CLO5	To enhance awareness of India's glory and global values, and to create considerate citizens who strive for the betterment of their family, college, workforce, and nation.	1 Remembering 2 Understanding 3 Applying
CLO6	To inspire students to strive for a higher sense of character by learning from role models who have lived principled, disciplined, and value-based lives.	1 Remembering 2 Understanding 3 Applying

Mapping of CLOs with POs & PSOs:

Course Learning Outcomes	Programme Outcomes (POs)																Programme Specific Outcome (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	PSO1	PSO2	PSO3
CLO1							3	2	2			3	2	1		1			
CLO2							3	3				3		2	2	1			
CLO3		3		1			3	3			2	3				3			
CLO4							3	3				3			2	2			
CLO5							3					3			2	1			
CLO6	1	1					3	3	2			3	1		2				

3: High, 2: Medium, 1: Low